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(54)【発明の名称】 ポリオレフィン樹脂発泡体の圧縮成形方法

(57)【要約】

【課題】 非加熱による圧縮成形により、効率良く凹凸形状を有するポリオレフィン樹脂発泡体を成形する方法を提供する。

【解決手段】 ポリオレフィン樹脂発泡体を対向する圧縮型間に圧縮し、該圧縮型に接するポリオレフィン樹脂発泡体面に凹凸形状を施す圧縮成形方法において、引張試験 (J I S K 7 1 1 3) における引張速度 5.0 mm/分、測定温度 23℃の応力-歪み曲線が、(1) 降伏点を有し、(2) 降伏点以外にて降伏強度と同じ応力を示す点での歪みが 400% 以上であることを満足するポリオレフィン樹脂よりなり、さらに気泡構造が厚み方向に縦長であり、且つ、厚み方向の気泡径/厚み方向に垂直な方向の気泡径で表される気泡径比が 2~10 であるポリオレフィン樹脂発泡体の圧縮成形を非加熱にて行う。

## 【特許請求の範囲】

【請求項 1】 ポリオレフィン樹脂発泡体を対向する圧縮型間にて圧縮し、該圧縮型に接するポリオレフィン樹脂発泡体面に凹凸形状を施す圧縮成形方法において、引張試験 (J I S K 7113 1981年) における引張速度 50 mm/分、測定温度 23℃の応力-歪み曲線が、(1) 降伏点を有し、(2) 降伏点以外にて降伏強度と同じ応力を示す点での歪みが 400% 以上であることを満足するポリオレフィン樹脂よりなり、さらに気泡構造が厚み方向に縦長であり、且つ、厚み方向の気泡径／厚み方向に垂直な方向の気泡径で表される気泡径比が 2～10 であるポリオレフィン樹脂発泡体の圧縮成形を非加熱にて行うことを特徴とするポリオレフィン樹脂発泡体の圧縮成形方法。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は、種々の建材、断熱材、カバー、包装材等に用いられる凹凸形状を有するポリオレフィン樹脂発泡体の圧縮成形方法に関するものである。

## 【0002】

【従来の技術】 従来より発泡体の持つ緩衝性、断熱性等の機能を有効、且つ多分野に利用するため、発泡体にさまざまな形状を施す試みがなされてきた。例えば、ポリオレフィン樹脂を原料として用いる場合には、その熱可塑性を利用し、加熱された金型により発泡体を圧縮して加熱変形させることにより形状を付与した後、冷却固化して製品を得る方法、若しくは裁断、打ち抜き、スライス等の切断加工方法、また、所定形状のパッド材、若しくは表面材を接着剤を用いて張り合わせる方法などが工業的に広く採用されている。

## 【0003】

【発明が解決しようとする課題】 しかし、従来より行われてきた発泡体を熱圧縮により一度加熱軟化させて製品を得る方法においては、発泡体の持つ断熱機能により発泡体の加熱冷却に時間がかかり、成形サイクルが長く生産性に劣るといった問題があり、これを金型の面数を増加させることにより解決しようとすると、設備負担が大きくなるとともに、作業性の悪化を招く。さらに、発泡体を加熱軟化させることに伴い、発泡体中の気泡が融着してしまい、軽量性、断熱性等を損なうという不都合が生じる。

【0004】 また、これら圧縮を非加熱にて行い、発泡体に凹凸形状を施そうとする場合には、発泡体の緩衝能力により、凹凸形状は即座に、あるいは徐々に回復してしまうため凹凸形状を施すことは困難であった。また、硬質プラスチックにより構成される剛性の高い発泡体を用いて非加熱圧縮を行えば、上記凹凸の回復は低減化されるが、脆さの増加により、複雑な形状を付与しようとすると、あるいは凹凸が大きい場合に、細部に割れを

生じやすくなるため、凹凸転写性に乏しい製品となってしまう。

【0005】 また、発泡体を裁断、打ち抜き、スライス等により所定形状に切断加工する方法にあっては、形状の複雑化に伴い、人手、あるいは作業時間の増加をもたらし、製品のコストアップにつながるため、加工できる製品は単純な形状に限られてしまう。

【0006】 さらに、所定形状のパッド材、あるいは表面材を接着剤を用いて張り合わせる方法にあっては、発泡体と接着剤、あるいは張り合わせ材と接着剤との接着性、発泡体の表面性などの条件が接着強度に強く関係するため、使用される発泡体はこれら条件に見合う発泡体に限定されてしまう。また、接着剤塗布工程、張り合わせ工程、接着剤乾燥工程、プレス工程、冷却工程などの複数の工程が必要となるため、設備負担が大きく、成形サイクルが長くなるといった問題がある。

【0007】 本発明の目的は、上記従来の問題を解消した非加熱による圧縮成形により、効率良く凹凸形状を有するポリオレフィン樹脂発泡体を成形する方法を提供することにある。

## 【0008】

【課題を解決するための手段】 本発明者は、上記問題に関して鋭意検討した結果、特定のポリオレフィン樹脂発泡体に非加熱で圧縮を加えることにより、優れた転写性を有する凹凸形状の発泡体が得られることを見い出し、本発明を完成させるに至った。

【0009】 即ち、本発明はポリオレフィン樹脂発泡体を対向する圧縮型間にて圧縮し、該圧縮型に接するポリオレフィン樹脂発泡体面に凹凸形状を施す圧縮成形方法において、引張試験における引張速度 50 mm/分の応力-歪み曲線が、(1) 降伏点を有し、(2) 降伏点以外にて降伏強度と同じ応力を示す点での歪みが 400% 以上であることを満足するポリオレフィン樹脂よりなり、さらに気泡構造が厚み方向に縦長であり、且つ、厚み方向の気泡径／厚み方向に垂直な方向の気泡径で表される気泡径比が 2～10 であるポリオレフィン樹脂発泡体の圧縮成形を非加熱にて行うことを特徴とするポリオレフィン樹脂発泡体の圧縮成形方法に関するものである。

【0010】 以下、本発明について詳述する。

【0011】 本発明にて発泡体として用いられるポリオレフィン樹脂としては、引張試験 (J I S K 7113 1981年) における引張速度 50 mm/分、測定温度 23℃の応力-歪み曲線が (1) 降伏点を有し、(2) 降伏点以外にて降伏強度と同じ応力を示す点での歪みが 400% 以上であるポリオレフィン樹脂である。ここで、降伏点が認められないポリオレフィン樹脂より構成される発泡体を凹凸形状を有する圧縮型にて非加熱圧縮した場合、発泡体の凹凸部に割れが生じたり、又は圧縮後即座に、若しくは徐々に凹凸形状が回復してしま

い凹凸転写性に優れた発泡体は得られないことから好ましくない。また、降伏点以外にて降伏強度と同じ応力を示す点での歪みが400%に満たないポリオレフィン樹脂より構成される発泡体を、上記に同じく非加熱圧縮した場合、得られる発泡体は弾性的に変形してしまい、付与した凹凸形状が持続しないものとなることから好ましくない。

【0012】本発明にて用いられるポリオレフィン樹脂としては、引張試験 (JIS K 7113 1981年) における引張速度50mm/分、測定温度23℃の応力-歪み曲線が(1)降伏点を有し、(2)降伏点以外にて降伏強度と同じ応力を示す点での歪みが400%以上であるポリオレフィン樹脂であればいかなるものも用いることができ、例えば、引張試験 (JIS K 7113 1981年) における引張速度50mm/分、測定温度23℃の応力-歪み曲線が(1)降伏点を有し、(2)降伏点以外にて降伏強度と同じ応力を示す点での歪みが400%以上であるエチレン-プロピレンブロック共重合体、中・低圧重合法にて重合することによって得られる密度が0.94~0.97g/cm<sup>3</sup>の高密度ポリエチレン、ポリプロピレンホモポリマー、エチレン-プロピレンランダム共重合体、又はプロピレン- $\alpha$ -オレフィン共重合体等が挙げられ、ここで $\alpha$ -オレフィンとしては、例えば1-ブテン、1-ペンテン、1-ヘキセン、4-メチル-1-ペンテン、1-オクテン等を挙げることができる。また、これらポリオレフィン樹脂は、単独又は2種以上を併用して用いてもよい。

【0013】また、本発明において用いられるポリオレフィン樹脂は、フィラー等を混合したものであってもよく、該フィラーとしては、例えばタルク、炭酸カルシウム、シリカ、マイカ、カーボンブラック、金属粉、ガラス繊維、カーボン繊維、水酸化マグネシウム、三酸化アンチモン、ほう酸亜鉛、臭素化合物、セラミック、ゼオライト等が挙げられる。また、これらフィラーは単独又は併用して用いることができる。

【0014】本発明に用いられるポリオレフィン樹脂発泡体は、気泡構造が厚み方向に縦長であり、且つ、厚み方向の気泡径/厚み方向に垂直な方向の気泡径で表される気泡径比が2~10であることを特徴とするものである。気泡径比が2未満である場合には、非加熱圧縮による発泡体の変形が弾性的なものとなり、凹凸形状が持続せず好ましくない。一方、気泡径比が10を超える場合には、発泡体の内部の気泡を隔てる気泡壁が極めて細長く延伸された状態となるため、発泡体の強度が著しく低下し、圧縮時において発泡体自体が変形又はつぶれてしまうために好ましくない。

【0015】上記ポリオレフィン樹脂発泡体の製造方法としては、気泡構造が厚み方向に縦長であり、且つ、厚み方向の気泡径/厚み方向に垂直な方向の気泡径で表される気泡径比が2~10であるポリオレフィン樹脂発泡

体が得られれば特に限定されるものではなく、その製造方法の1例を以下に示す。

【0016】ポリオレフィン樹脂に、加熱によって分解しガスを発生し得る化学発泡剤、例えばアゾジカルボンアミド、N, N'-ジニトロソペンタメチレンテトラミン、4, 4'-オキシスピス(ベンゼンスルホニルヒドラジド)、炭酸水素ナトリウムなどと、必要に応じて過酸化物などの化学架橋剤を混合し、該混合物を化学発泡剤、架橋剤が分解しない温度に保持させたまま溶融混練し、例えばシート状等の成形体に成形する。そして得られた発泡性を有するシートは、例えば図1に示すように、対向する一対の成形型1及び2内にて加圧されるとともに、上記発泡剤の分解温度以上に加熱され、次いで上記成形型を開放することにより加圧樹脂が2次元的に膨張し、所望する発泡体3に変換される。

【0017】上記発泡体の製造方法にて加えられる化学架橋剤としては、例えばベンゾイルパーオキサイド、2, 5-ジメチル-2, 5-ジ-*t*-ブチルパーオキシヘキサン、2, 5-ジメチル-2, 5-ジ-*t*-ブチルパーオキシヘキシン-3、ジクミルパーオキサイド、*t*-ブチルヒドロキシパーオキサイド等の有機過酸化物、あるいは1, 9-ノナンビススルフォンアザイド等のアジド化合物、またはビニルトリエトキシシラン等のシラン化合物等がある。また、この場合、架橋を促進する架橋助剤として、例えばトリアリルシアヌレート、トリアリルイソシアヌレート、トリメチロールプロパントリメタクリレート、1, 2-ボリブタジエン、ジビニルベンゼン等を併用することができる。

【0018】また、上記架橋剤の混合量は0~0.5重量%であることが好ましく、0.5重量%を超えて混合される場合には、樹脂中に高濃度の架橋構造が導入され、発泡時における樹脂の粘度が著しく上昇することから、気泡の成長が阻害され、一方向に細長く延伸された気泡を得ることができない。

【0019】本発明においてポリオレフィン樹脂発泡体に非加熱で凹凸形状を施す圧縮型としては、例えば対向する一対の型からなり、型締めにより型面が発泡体表面に接して発泡体を圧縮することのできるものや、外周面が対向する一対のロールからなり、互いに内向きに回転するロールの隙間にて発泡体を圧縮することのできるものがある。

【0020】また、上記圧縮型面には凹凸部が設けられ、これら凹凸部がポリオレフィン樹脂発泡体面に転写されることにより、凹凸形状を有するポリオレフィン樹脂発泡体が得られる。なお、上記圧縮型面の凹凸形状の種類は特に限定されるものでなく、エンボス模様、絞模様、山切り、円錐、四角柱、四角錐、三角錐、半球等の凹凸形状を単独、あるいは複合化させ用いることができる。

【0021】(作用) 発泡体を非加熱にて圧縮し、型転

写性に優れた製品を得るには、圧縮型間で圧縮される場合において、発泡体を塑性的に変形させなければならず、しかも、複雑な凹凸細部に割れを発生させてはならない。本発明者は、これら課題の解決に、発泡体を構成するポリオレフィン樹脂、及び発泡体の気泡構造が重要な役割を果たすことを見い出した。以下にその説明を述べる。

【0022】発泡体中の気泡周囲の樹脂は、発泡時に気泡の成長に伴いシート、あるいはフィルム状に延伸される。つまり、発泡体中の気泡を隔てる気泡壁はシート、あるいはフィルム状の樹脂であることから、発泡体は延伸されたシート、あるいはフィルム状成形体の集合体とも考えることができる。従って、発泡体を圧縮により塑性的に変形させることはすなわち、上記フィルム状成形体を塑性的に変形させることに深く関わるのである。

【0023】上記シート、あるいはフィルム状成形体の力学的性質を評価する方法として、従来より引張試験方法が一般的な方法として広く用いられている。引張試験では、シート、あるいはフィルム状に成形された樹脂試験片を機械的に引っ張り、各歪みに対する応力値が曲線にて表される。本発明に用いられるポリオレフィン樹脂の応力-歪み曲線は、例えば図2に示すものとなる。なお、図2にて4は降伏点であり、引張試験による応力-歪み曲線上で、応力の変化無しに歪みの増加が認められる最初の点として定義され、また、この点における応力は一般に降伏強度と呼ばれる。図2の応力-歪み曲線において、歪み0の点から降伏点4までは歪みの変化に伴い応力が増加することから、変形した試験片には元に戻ろうとする力が加わっていることになり、塑性的に変形する割合の大きい領域といえる。しかし、降伏点以降には変形による応力の増加が認められない領域が存在し、このような領域では変形が塑性的要素を持ち合わせている。また、前記塑性的要素を有する変形領域の終了した点5以降は、再び、変形に対して応力の増加が認められるため、試験片は曲線上5の点と曲線上5以降の点との間にて塑性的に変形する割合が大きくなることとなる。

【0024】従って、前記発泡体中のシート、あるいはフィルム状成形体を圧縮時において塑性的に変形せんには、応力-歪み曲線にて塑性的変形の割合が大きい領域が、より高範囲にわたって存在するような樹脂を用いて発泡体を成形すればよい。

【0025】すなわち、本発明におけるポリオレフィン樹脂は引張試験における応力-歪み曲線にて降伏点を有し、且つ、降伏点以外にて降伏強度と同じ応力を示す点での歪みが40%以上であるため、該ポリオレフィン樹脂により構成される発泡体は、圧縮型による圧縮時において塑性的な変形の割合の大きいものとなる。

【0026】一方、従来緩衝用途に使用されるような柔軟な発泡体を構成する樹脂の引張試験における応力-歪み曲線は、例えば図3に示すようなタイプに分類され

る。図3に示す応力-歪み曲線には降伏点が無く、歪みの増加に伴い応力が増加し続けるため、塑性的な変形の割合が大きい。従って、このような応力-歪み曲線により表される樹脂を構成材料とする発泡体は、変形に対して柔軟、且つ、塑性的な回復性を示すものの、圧縮型を用いた非加熱圧縮による凹凸形状の転写性には劣る。

【0027】また、従来塑性的変形の割合が大きい硬質発泡体の多くは、例えば、図4、あるいは図5に示すタイプの応力-歪み曲線で表される樹脂を構成材料としている。図4に示す応力-歪み曲線は、変形によって降伏点に到達する以前にて試験片が破断することを表しており、また、図5に示す応力-歪み曲線は、降伏点付近にて試験片が破断することを表している。従って、図4、あるいは5に示すような応力-歪み曲線を示す樹脂を原料として発泡体が形成される場合、このような発泡体は微少な圧縮範囲においては塑性的に変形する特徴を示すが、塑性的変形限界を超えるような圧縮に対しては、発泡体を構成する前記シート、あるいはフィルム上成形体が破断してしまい、発泡体に割れを発生させることとなる。

【0028】また、本発明における発泡体の気泡構造は、発泡体を構成する前記ポリオレフィン樹脂の特徴を最大限生かすことを目的として考案されたものであり、その説明を以下に述べる。

【0029】本発明に用いられるポリオレフィン樹脂は塑性的変形の割合が大きい樹脂であるが、応力-歪み曲線における降伏点に至るまでの範囲では塑性的変形の割合が大きい。従って、上記ポリオレフィン樹脂から構成される発泡体を用いて、圧縮型間にて圧縮を行い、凹凸

30 形状を付与する場合において、発泡体を構成する前記シート、あるいはフィルム状気泡壁が塑性的変形の割合が大きくなる領域にまで変形されることが必要になる。本発明に用いられる発泡体はその気泡構造が縦長であることにより、例えば、図6に示すように、気泡壁が発泡体の厚み方向から圧縮を受けた場合において、大きな折れ曲がりの変形を示す。一方、球状気泡を有する発泡体を構成する気泡壁は、圧縮を受けた場合において、その形状を大きく変化させることはない。すなわち、本発明における発泡体を構成するシート、あるいはフィルム状気泡壁は、球状気泡を有する発泡体を構成する気泡壁に対して、発泡体の変形量当たりの気泡壁の変形量は大きくなる。

【0030】従って、圧縮型間での圧縮において、凹凸が小さい場合であっても、気泡壁は塑性的な変形の割合が大きくなるに足る変形を受けることができ、複雑、あるいは微少な形状であっても、型転写性の良好な発泡体が得られるのである。

【0031】

【実施例】以下、実施例、及び比較例によって本発明を50 更に詳しく説明するが、本発明はこれら実施例に限定さ

れるものではない。

【0032】実施例1～2にて用いられる発泡体の合成例を以下に示す。

【0033】合成例1

高密度ポリエチレン（東ソー株式会社製、商品名ニポロンハード4010）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社製、商品名ビニホールAC'1C）5重量部、架橋剤として2,5-ジメチルルージーt-ブチルパーオキシヘキシン-3（日本油脂株式会社製、商品名パーへキシン25B-40）0.4重量部とからなる混合物を調整した。該混合物を50mmφ押出機により溶融混練するとともに、Tダイを通して未発泡シートとして押し出した。

【0034】次いで、該未発泡シートを、180℃に維持されているそれぞれ凹、凸形状を有した一対の対向する成形型間に挿入し、20kgf/cm<sup>2</sup>の圧力にて加圧した後、該成形型を200℃まで昇温して発泡剤を分解させることにより、溶融樹脂中にガスを発生させた。続いて上記成形型を130℃に冷却した後、開放することにより発泡体を得た。

【0035】得られた発泡体は、その気泡が上記金型の開放方向、つまり厚み方向に縦長のものであり、発泡倍率は10倍、厚み30mm、厚み方向の気泡径／厚み方向に垂直な方向の気泡径で表される気泡径比は3～7の範囲である発泡体であった。

合成例2

エチレン-プロピレンランダム共重合体（チッソ石油化学株式会社製、商品名チッソポリプロXF1800）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社、商品名ビニホールAC'3）7重量部、架橋剤として2,5-ジメチルルージーt-ブチルパーオキシヘキサン（日本油脂株式会社製、商品名パーへキサン25B-40）0.08重量部、架橋助剤としてジビニルベンゼン（東京化成工業株式会社製）0.8重量部とからなる混合物を調整した後、合成例1と同様にシート成形後、発泡成形を行った。

【0036】得られた発泡体は、その気泡が厚み方向に縦長であり、発泡倍率は15倍、厚み45mm、気泡径比は4～8の範囲である発泡体であった。

【0037】実施例1

以下、本発明を具現化した実施例につき、図7、及び8に基づいて説明する。本実施例は上記合成例1において得られた発泡体から凹凸形状を有する発泡体を成形する場合に、本発明を適用した場合である。

【0038】図7における圧縮型6は圧縮時に発泡体面に接する圧縮面が凹凸形状を有するものであり、溝長さ7を10mm、溝幅8を5mmとした。

【0039】発泡体10は表面から厚み1mmがスライスされ、発泡体のスライス面が圧縮型面に接するようにして図8（a）に示すように、加熱されていない圧縮型

6、及び平板状圧縮型9の間に設置され、引き続き圧縮型を下降させることにより、凹凸形状の圧縮面を発泡体面に接しさせ、次いで発泡体を加圧することにより、図8（b）に示すように、溝長さ分だけ、つまり10mm圧縮させた。そして、図8（b）の状態のまま1分保持した後、図8（c）に示すように金型を開放し、発泡体を取り出した。

【0040】実施例2

合成例2において得られた発泡体を用い、実施例1と同様の方法により、圧縮型間での圧縮成形を行った。

【0041】比較例1～4

表1に示す発泡体を実施例1と同様の方法により、圧縮型間での圧縮成形を行った。なお、表1に示す1～5の発泡体は以下に説明するものである。

【0042】比較例1：実施例1の発泡体を任意の位置において厚み方向に平衡な方向より切断し、切断面が圧縮型の圧縮面に接するようにした発泡体である。

【0043】比較例2：ダウ化工株式会社製、商品名スタイルフォーム

20 比較例3：東洋ゴム工業株式会社、商品名ソフラン-Rボード

比較例4：株式会社ブリヂストン、商品名エバーライト  
比較例5

エチレン-酢酸ビニル共重合体（東ソー株式会社製、商品名ウルトラセン540）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社、商品名ビニホールAC'3）5重量部、架橋剤として2,5-ジメチル-2,5-ジ-ルージーt-ブチルパーオキシヘキシン-3（日本油脂株式会社製、商品名パーへキ

30 シン25B-40）0.3重量部とからなる混合物を調整した後、合成例1と同様にシート成形した。そして、該未発泡シートを、180℃に維持されているそれぞれ凹、凸形状を有した一対の対向する成形型間に挿入し、20kgf/cm<sup>2</sup>の圧力にて加圧した後、該成形型を200℃まで昇温して発泡剤を分解させることにより、溶融樹脂中にガスを発生させた。続いて上記成形型を100℃に冷却した後、開放することにより発泡体を得た。得られた発泡体は、気泡が厚み方向に縦長であり、発泡倍率は10倍、厚み30mm、気泡径比は3～6の範囲である発泡体が得られた。そして、得られた発泡体を用い、実施例1と同様の方法により、圧縮型間での圧縮成形を行った。

【0044】比較例6

低密度ポリエチレン（東ソー株式会社製、商品名ペトロセン339）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社、商品名ビニホールAC'3）5重量部、架橋剤として2,5-ジメチル-2,5-ジ-ルージーt-ブチルパーオキシヘキシン-3（日本油脂株式会社製、商品名パーへキシン25B-4

50 0.3重量部とからなる混合物を調整した後、合成

例1と同様にシート成形した。そして、該未発泡シートを、180℃に維持されているそれぞれ凹、凸形状を有した一対の対向する成形型間に挿入し、20kgf/cm<sup>2</sup>の圧力にて加圧した後、該成形型を200℃まで昇温して発泡剤を分解させることにより、溶融樹脂中にガスを発生させた。続いて上記成形型を110℃に冷却した後、開放することにより発泡体を得た。得られた発泡体は、気泡が厚み方向に縦長であり、発泡倍率は10倍、厚み30mm、気泡径比は2～5の範囲である発泡体が得られた。そして、得られた発泡体を用い、実施例1と同様の方法により、圧縮型間での圧縮成形を行った。

【0045】比較例7

高密度ポリエチレン（東ソー株式会社製、商品名ニポロンハード4010）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社、商品名ビニホールAC'1C）5重量部、架橋剤として2,5-ジメチル-2,5-ジー-*t*-ブチルバーオキシヘキシン-3（日本油脂株式会社製、商品名バー-ヘキシン25B-40）0.6重量部とからなる混合物を調整した後、合成例1と同様にシート成形をおこなった。そして該未発泡シートを、180℃に維持されている型合わせ部に向けてキャビティが拡散するようにキャビティの側面を傾斜させた分割金型のキャビティ内に挿入し、20kgf/cm<sup>2</sup>の圧力にて加圧した後、該成形型を200℃まで昇温して発泡剤を分解させることにより、溶融樹脂中にガスを発生させた。続いて上記成形型を130℃に冷却した後、開放することにより3次元的に膨張した発泡体を得た。

【0046】得られた発泡体は、その気泡構造が球状であり、発泡倍率10倍、厚み20mmの発泡体であった。そして、得られた発泡体を用い、実施例1と同様の方法により、圧縮型間での圧縮成形を行った。

【0047】比較例8

エチレン-プロピレンランダム共重合体（チッソ石油化学会社製、商品名チッソポリプロXF1800）100重量部に対して、発泡剤としてアゾジカルボンアミド（永和化成工業株式会社、商品名ビニホールAC'3）12重量部、架橋剤として2,5-ジメチル-*t*-ブチルバーオキシヘキサン（日本油脂株式会社製、商品名バー-ヘキサン25B-40）0.08重量部、架橋助剤としてジビニルベンゼン（東京化成工業株式会社製）0.8重量部とからなる混合物を調整した後、合成例1と同様にシート成形し、次いで発泡成形を行った。

【0048】得られた発泡体は、その気泡が厚み方向に縦長であり、発泡倍率は25倍、厚み75mm、気泡径比は6～15の範囲である発泡体であった。そして、得

られた発泡体を用い、実施例1と同様の方法により、圧縮型間での圧縮成形を行った。

【0049】実施例1～2、及び比較例1～8に用いた発泡体の特徴、及び圧縮型間での圧縮成形後の発泡体の特徴をまとめ、表1に示す。なお、表1中の各項目についての説明を以下に述べる。

【0050】（降伏点）圧縮成形に用いられる発泡体を、一対の対向するそれぞれ平板状の圧縮型を有する圧縮成形機により加熱圧縮して厚み1mmのシートに成形した後、得られたシートをJIS K 7113（1981年）に従い、2号形試験片に打ち抜き、引張速度50mm/分、測定温度23℃の条件にて引張試験を行った。そして、引張試験により得られた応力-歪み曲線から降伏点の有無を調べた。

【0051】（歪み量）上記降伏点有無の判断に用いた応力-歪み曲線から、降伏点における応力、即ち降伏強度を求めた。そして、応力-歪み曲線を歪み増加の方向に辿り、降伏点以外にて降伏強度と同じ応力を示す点における歪み量を求める。なお、歪み量は試験片における変化した標線間距離を元の標線間距離で除し、100を乗することによって得られる値である。

【0052】（気泡径比）圧縮成形に用いられる発泡体を、任意の位置において厚み方向に平衡な方向から切断し、該切断面の面積4cm<sup>2</sup>にて認められる気泡について、厚み方向の気泡径、及び厚み方向に垂直な方向の気泡径をそれぞれ測定し、厚み方向の気泡径を厚み方向に垂直な方向の気泡径にて除すことにより、気泡径比を求めた。

【0053】（割れ）圧縮型間での圧縮により、発泡体表層の気泡が破たり、発泡体表層が裂けたりする現象をいう。判定は目視により次の判定基準にしたがって判定した。

○：割れ、裂けともに無し

△：割れは有るが裂けは無し

×：割れ、裂けともに有り

（回復性）凹凸形状に圧縮された発泡体を取り出して24時間放置する。そして形成された凹凸部の溝の長さを測定した結果に基づき、次の判断基準によって判定した。

【0054】○：圧縮型の溝の長さに対して90%以上の長さの溝が発泡体に生成

△：圧縮型の溝の長さに対して10%以上90%未満の長さの溝が発泡体に生成

×：圧縮型の溝の長さに対して10%未満の長さの溝が発泡体に生成

【0055】

【表1】

	発泡体					割れ	回復性
	原料樹脂	降伏点	歪み屈 (%)	発泡倍率 (倍)	気泡径比 (-)		
実施例 1	高密度ポリエチレン	有	520	10	3~7	○	○
実施例 2	エチレン-プロピレンランダム共重合体	有	450	15	4~8	○	○
比較例 1	高密度ポリエチレン	有	520	10	0.1~0.3	○	△
比較例 2	ポリスチレン	無	-	30	1	×	△
比較例 3	硬質ポリウレタン	一	-	15	1	×	△
比較例 4	軟質ポリウレタン	無	-	15	1	○	△
比較例 5	エチレン-酢酸ビニル共重合体	一	-	10	3~6	○	×
比較例 6	低密度ポリエチレン	有	120	10	2~5	○	×
比較例 7	高密度ポリエチレン	有	500	10	1	○	△
比較例 8	エチレン-プロピレンランダム共重合体	有	480	25	6~15	△	○

## 【0056】

【発明の効果】本発明によれば、凹凸形状を有する発泡体を、圧縮型間での圧縮により容易に得ることができ。なぜなら、圧縮型は加熱冷却装置を必要としないため、設備簡便化により設備負担が軽減化され、工業的にも、多品種少量生産に好都合な成形方法と成り得る。また、加熱冷却時間が省け、複雑な工程も必要としないことから、成形サイクルが著しく改善された凹凸形状の発泡体を提供することができる。

【0057】本発明における圧縮成形方法は以上のような効果を発揮するため、以下に代表される多様な製品の成形に利用することができる。

【0058】(1) インバネ、ドアトリム、ピラー、天井材などの自動車部品

(2) 床、壁、天井などに関連する住宅建材

(3) 梱包、包装材

(4) 家電機器、携帯機器、情報関連機器等のカバー類

## 【図面の簡単な説明】

【図1】ポリオレフィン樹脂発泡体の成形方法を模式的に示した説明図である。

【図2】ポリオレフィン樹脂の引張試験時における応力-歪み曲線を示す概略図である。

【図3】柔軟な発泡体を構成する樹脂の引張試験時における応力-歪み曲線を示す概略図である。

【図4】硬質発泡体を構成する樹脂の引張試験時における応力-歪み曲線を示す概略図である。

【図5】硬質発泡体を構成する樹脂の引張試験時における応力-歪み曲線を示す概略図である。

【図6】ポリオレフィン樹脂発泡体を圧縮した場合における気泡形状を示す概略図である。

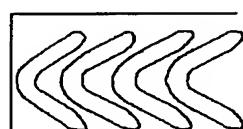
【図7】実施例1の圧縮成形型の型面における形状を模式的に示した説明図である。

【図8】実施例1におけるポリオレフィン樹脂発泡体の圧縮成形方法を模式的に説明した図である。

## 【符号の説明】

- 1 : 上金型
- 2 : 下金型
- 3 : 発泡体
- 4 : 降伏点
- 5 : 応力-歪み曲線における塑性的変形の割合の大きい領域が終了した点
- 6 : 凹凸面を有する圧縮型
- 7 : 圧縮型の溝の長さ部分
- 8 : 圧縮型の溝の幅部分
- 9 : 平板状圧縮型
- 10 : 圧縮成形に用いられる発泡体
- 11 : 凹凸形状を有する発泡体

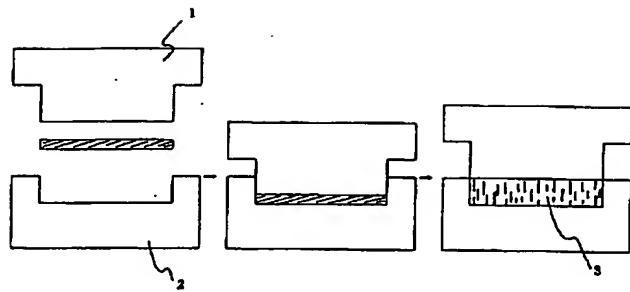
【図6】



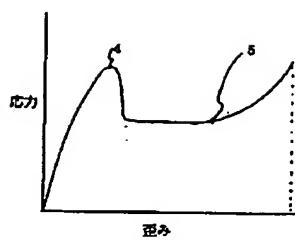
【図7】



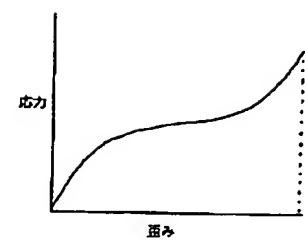
【図 1】



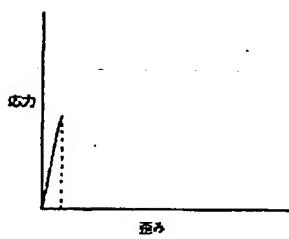
【図 2】



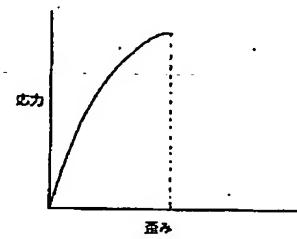
【図 3】



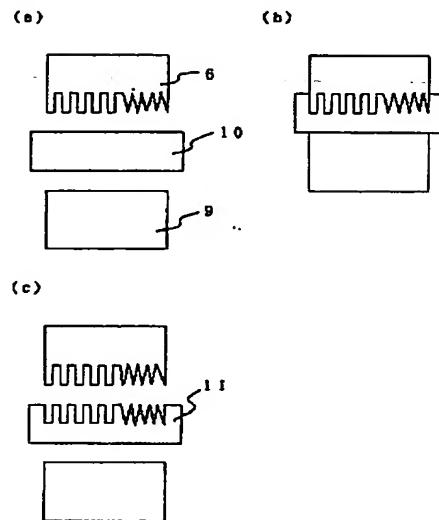
【図 4】



【図 5】



【図 8】



## PATENT ABSTRACTS OF JAPAN

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## (54) METHOD FOR COMPRESSION MOLDING OF POLYOLEFIN RESIN FOAM

## (57)Abstract:

PROBLEM TO BE SOLVED: To efficiently incorporate a convexo-concave shape by compression molding by non-heating.  
SOLUTION: In the method for compression molding polyolefin resin foam comprising the steps of compressing the foam between opposed compression molds, and forming a convexo-concave shape on the surface of the foam in contact with the molds, the foam made of polyolefin resin having 50mm/min of a tension speed of a tension test (JIS K 7113) and satisfying that a stress-strain curve at 23° C of a measured temperature has (1) a yield point and (2) a strain at a point indicating the same stress as a yield strength except the yield point is 400% or more, further a foam structure is longitudinally long in a thickness direction, and a bubble size ratio represented by (bubble size in thickness direction)/(bubble size in a direction perpendicular to thickness direction) is 2 to 10 is compression molded by non-heating.

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CLAIMS

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## [Claim(s)]

[Claim 1] In the compression-molding approach of giving a concavo-convex configuration to the polyolefin resin foam side which compresses polyolefin resin foam between the compression mold which counters, and touches this compression mold A part for speed-of-testing/ of 50mm in a tension test (JIS K 7113 1981), A stress-strain curve with a measurement temperature of 23 degrees C has (1) yield point, and it consists of polyolefin resin which satisfies that distortion by the point which shows the same stress as yield strength except (2) yield points is 400% or more. The compression-molding approach of the polyolefin resin foam characterized by performing compression molding of the polyolefin resin foam whose diameter ratios of air bubbles to which cellular structure is furthermore longwise expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction in the thickness direction are 2-10 by un-heating.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the compression-molding approach of the polyolefin resin foam which has the concavo-convex configuration used for various building materials, a heat insulator, covering, a packing material, etc.

[0002]

[Description of the Prior Art] Validity and in order to use for a field probably, the attempt which functions the buffer nature which foam has conventionally, adiathermic, etc. has been made in various configurations to foam. For example, in using polyolefin resin as a raw material, after giving a configuration by using the thermoplasticity, compressing foam with the heated metal mold, and carrying out heating deformation, the method of making the cutting processing approaches, such as a method of carrying out cooling solidification and obtaining a product or decision, punching, and a slice, and the pad material of a predetermined configuration, or facing rival using adhesives etc. is adopted widely industrially.

[0003]

[Problem(s) to be Solved by the Invention] However, in the approach of carrying out heating softening of the foam performed conventionally once by heat compression, and obtaining a product, heating cooling of foam takes time amount by the heat insulation function which foam has, there is a problem that a molding cycle is inferior to productivity for a long time, and if it is going to solve this by making the number of pages of metal mold increase, while a facility burden will become large, aggravation of workability is invited. Furthermore, in connection with carrying out heating softening of the foam, the air bubbles in foam weld and the inconvenience of spoiling lightweight nature, adiathermic, etc. arises.

[0004] Moreover, when un-heating tended to perform these compression and it was going to give a concavo-convex configuration to foam, it was difficult to give a concavo-convex configuration according to the buffer capacity of foam, in order to recover a concavo-convex configuration immediately or gradually. Moreover, if non-heating compression is performed using the rigid high foam constituted by the rigid plastic, although reduction-ized, since recovery of the above-mentioned irregularity becomes easy to produce a crack into details when the increment in brittleness tends to give a complicated configuration, or when irregularity is large, it will become a scarce product at concavo-convex imprint nature.

[0005] Moreover, if it is in the approach of carrying out cutting processing of the foam by decision, punching, a slice, etc. at a predetermined configuration, since the increment in a help or working hours is brought about and it leads to the cost rise of a product with complication of a configuration, a processible product will be restricted to a simple configuration.

[0006] Furthermore, if it is in the approach of making the pad material of a predetermined configuration, or facing rivaling using adhesives, since conditions, such as the adhesive property of foam, adhesives, or lamination material and adhesives and the front-face nature of foam, are strongly related in bond strength, the foam used will be limited to the foam corresponding to these conditions. Moreover, since two or more processes, such as an adhesives spreading process, a lamination process, an adhesives desiccation process, a press process, and a cooling process, are needed, there is a problem that a facility burden is large and a molding cycle becomes long.

[0007] The object of this invention is to offer the approach of fabricating the polyolefin resin foam which has a concavo-convex configuration efficiently with compression molding by un-heating [ which solved the above-mentioned conventional problem ].

[0008]

[Means for Solving the Problem] As a result of examining the above-mentioned problem wholeheartedly, by applying compression to specific polyolefin resin foam by un-heating, this invention person finds out that the foam of a concavo-convex configuration which has the outstanding imprint nature is obtained, and came to complete this invention.

[0009] Namely, this invention compresses polyolefin resin foam between the compression mold which counters, and sets it to the compression-molding approach of giving a concavo-convex configuration to the polyolefin resin foam side which touches this compression mold. Speed-of-testing the stress-strain curve for /of 50mm in a tension test has (1) yield point. (2) It consists of polyolefin resin which satisfies that distortion by the point which shows the same stress as yield strength is 400% or more except the yield point. Cellular structure is still more nearly longwise in the thickness direction. The diameter ratio of air bubbles expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction is related with the compression-molding approach of the polyolefin resin foam characterized by performing compression molding of the polyolefin resin foam which is 2-10 by un-heating.

[0010] Hereafter, this invention is explained in full detail.

[0011] Distortion by the point which a part for speed-of-testing/of 50mm in a tension test (JIS K 7113 1981) and a stress-strain curve with a measurement temperature of 23 degrees C have (1) yield point as polyolefin resin used as foam in this invention, and shows the same stress as yield strength except (2) yield points is polyolefin resin which is 400% or more. When non-heating compression of the foam which consists of polyolefin resin in which the yield point is not accepted here is carried out with the compression mold which has a concavo-convex configuration, the foam which the crack arose in the concavo-convex section of foam, or the concavo-convex configuration was recovered immediately or gradually after compression, and was excellent in concavo-convex imprint nature is not desirable from not being obtained. Moreover, when distortion by the point which shows the same stress as yield strength except the yield point carries out non-heating compression of the foam which consists of polyolefin resin which is not filled to 400% as well as the above, the foam obtained is not desirable from becoming what transforms elastically and the given concavo-convex configuration does not maintain.

[0012] As polyolefin resin used in this invention A part for speed-of-testing/of 50mm in a tension test (JIS K7113 1981), A stress-strain curve with a measurement temperature of 23 degrees C has (1) yield point, and anythings can be used if distortion by the point which shows the same stress as yield strength except (2) yield points is polyolefin resin which is 400% or more. A part for for example, speed-of-testing/of 50mm in a tension test (JIS K 7113 1981). The ethylene-propylene block copolymer whose distortion by the point which a stress-strain curve with a measurement temperature of 23 degrees C has (1) yield point, and shows the same stress as yield strength except (2) yield points is 400% or more. The consistency obtained by carrying out a polymerization by inside and the low voltage polymerization method The high density polyethylene of 0.94 - 0.97 g/cm<sup>3</sup>, A polypropylene homopolymer, an ethylene-propylene random copolymer, or a propylene-alpha olefin copolymer is mentioned. Here as an alpha olefin For example, 1-butene, 1-pentene, 1-hexene, 4-methyl-1-pentene, 1-octene, etc. can be mentioned. Moreover, independent or two sorts or more may be used together and used for these polyolefin resin.

[0013] Moreover, the polyolefin resin used in this invention may mix a filler etc., and talc, a calcium carbonate, a silica, a mica, carbon black, a metal powder, a glass fiber, carbon fiber, a magnesium hydroxide, an antimony trioxide, waxy acid zinc, a bromine compound, a ceramic, a zeolite, etc. are mentioned as this filler, for example. moreover, these fillers are independent — or it can use together and use.

[0014] The polyolefin resin foam used for this invention is characterized by the diameter ratios of air bubbles to which cellular structure is longwise expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction in the thickness direction being 2-10. When the diameter ratio of air bubbles is less than two, deformation of the foam by non-heating compression will become elastic, and a concavo-convex configuration continues and is not desirable. Since the reinforcement of foam falls remarkably and it sets on the other hand at the time of compression, since the cellular wall which separates the air bubbles in foam will be in the condition of having been extended very long and slender when the diameter ratio of air bubbles exceeds 10, and foam itself is deformed or crushed, it is not desirable.

[0015] It is not limited especially if the polyolefin resin foam whose diameter ratios of air bubbles to which cellular structure is longwise expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction in the thickness direction as the manufacture approach of the above-mentioned polyolefin resin foam are 2-10 is obtained, and one example of the manufacture approach is shown below.

[0016] Chemistry cross linking agents, such as a peroxide, are mixed with — dinitrosopentamethylenetetramine, and chemistry foaming agent which decomposes into polyolefin resin with heating and may generate gas, for example, AZOJI carvone amide, N, and N'4, 4'-oxy-SUBISU (benzenesulphonyl hydrazide), a sodium hydrogencarbonate, etc. if needed, while this mixture had been made to hold to the temperature which a chemistry foaming agent and a cross linking agent do not decompose, melting kneading is carried out, for example, it fabricates to Plastic solids, such as the shape of a sheet. And it is heated more than the decomposition temperature of the above-mentioned foaming agent, and by subsequently opening the above-mentioned die, application-of-pressure resin expands two-dimensional, and the sheet which has the acquired fizz is changed into the foam 3 for which it asks while being pressurized within the die 1 of the couple which counters, and 2, as shown in drawing 1.

[0017] As a chemistry cross linking agent added by the manufacture approach of the above-mentioned foam, there are silane compounds, such as azide compounds, such as organic peroxide [, such as benzoyl peroxide, 2,5-dimethyl-2,5-di-t-butyl peroxyhexane, 2, the 5-dimethyl-2 5-G t-butyl par OKISHIHEKISHIN -3, dicumyl peroxide, and t-butyl hydroxy peroxide, ] or 1, and 9-nonane bis-sulfone AZAIDO, or vinyltriethoxysilane, etc., for example. Moreover, for example, a triaryl SHIANU rate, triallyl isocyanurate, trimethylolpropanetrimethacrylate, 1, 2-polybutadiene, a divinylbenzene, etc. can be used together as a bridge formation assistant which promotes bridge formation in this case.

[0018] Moreover, as for the amount of mixing of the above-mentioned cross linking agent, it is desirable that it is 0 — 0.5 % of the weight, when mixed exceeding 0.5 % of the weight, since the high-concentration structure of cross linkage is introduced into resin and the viscosity of the resin at the time of foaming rises remarkably, growth of air bubbles is checked and the air bubbles extended by the one direction long and slender cannot be obtained.

[0019] It consists of a mold of the couple which counters, for example as compression mold which gives a concavo-convex configuration to polyolefin resin foam by un-heating in this invention, and it consists of a roll of that into which a mold face can compress foam in contact with a foam front face by eye a mold clamp, and the couple which a peripheral face counters, and there are some which can compress foam in the clearance between the rolls which rotate to the inside sense mutually.

[0020] Moreover, the concavo-convex section is prepared in the above-mentioned compression mold side, and when these irregularity section is imprinted by the polyolefin resin foam side, the polyolefin resin foam which has a concavo-convex configuration is obtained. in addition, the thing to which especially the class of concavo-convex configuration of the above-mentioned compression mold side is limited — it is not — concavo-convex configurations, such as an embossing pattern, a variegated pattern, the crest end, a cone, the square pole, a rectangular-head drill, a triangular pyramid, and a semi-sphere, — independence — or it can be made to be able to compound-ize and can use.

[0021] (Operation) Foam is compressed by un-heating, in order to obtain the product excellent in mold imprint nature, when compressed between compression mold, foam must be made to transform in plasticity, and, moreover, complicated concavo-convex details must not be made to generate a crack. this invention person found out playing a role with the polyolefin resin which constitutes foam and the cellular structure of foam important for solution of these technical problems. The explanation is described below.

[0022] The resin of the perimeter of air bubbles in foam is extended a sheet or in the shape of a film with growth of air bubbles at the time of foaming. That is, since the cellular wall which separates the air bubbles in foam is resin of the shape of a sheet or a film, foam can be considered to be also the aggregate of the extended sheet or a film-like Plastic solid. Therefore, it is deeply concerned with making it transform in plasticity to make foam transform in plasticity by compression, i.e., the above-mentioned film-like Plastic solid.

[0023] The tension test approach is widely used as a general approach from before as an approach of evaluating the mechanical property of the above-mentioned sheet or a film-like Plastic solid. by the tension test, a sheet or the resin test piece fabricated in the shape of a film is pulled mechanically, and the stress value over each distortion is expressed with a curve. The stress-strain curve of the polyolefin resin used for this invention is shown in drawing 2 . In addition, 4 is the yield point, and it defines as drawing 2 as first point that the increment in distortion is accepted without change of stress on the stress-strain curve by the tension test, and, generally the stress in this point is called yield strength. In the stress-strain curve of drawing 2 , the force in which it returns to the test piece which deformed from stress increasing with change of distortion till the yield point 4 will be added from the point of distortion 0, and it can be called the field where the rate which deforms elastically is large. However, after the yield point, the field where the increment in the stress by deformation is not accepted exists, and deformation has the plastic-like element with it in such a field. Moreover, after the point 5 which the deformation field which has said plastic-like element ended, again, since the increment in stress is accepted to deformation, the rate which a test piece deforms elastically between the point of curve top 5 and the point after curve top 5 will become large.

[0024] Therefore, in order to make the sheet or film-like Plastic solid in said foam deform in plasticity at the time of compression, the field where the rate of the plastic-like deformation is large should just fabricate foam in a stress-strain curve using resin which exists over the high range more.

[0025] That is, since distortion by the point which the polyolefin resin in this invention has the yield point in the stress-strain curve in a tension test, and shows the same stress as yield strength except the yield point is 400% or more, the foam constituted by this polyolefin resin becomes what has the large rate of plasticity-deformation at the time of compression by compression mold.

[0026] The stress-strain curve in the tension test of the resin which, on the other hand, constitutes flexible foam which is conventionally used for a buffer application is classified into a type as shown in drawing 3. Since there is no yield point in the stress-strain curve shown in drawing 3 and stress continues increasing with the increment in distortion, the rate of elastic deformation is large. Therefore, although the foam which makes a component the resin expressed by such stress-strain curve shows adaptability and elastic recoverability to deformation, it is inferior to the imprint nature of the concavo-convex configuration by the non-heating compression which used compression mold.

[0027] Moreover, many of hard foam with the conventionally large rate of the plastic-like deformation makes the component the resin expressed with the stress-strain curve of the type shown in drawing 4 or drawing 5. The stress-strain curve which the stress-strain curve shown in drawing 4 means that a test piece fractures before reaching according to deformation at the yield point, and is shown in drawing 5 means that a test piece fractures near the yield point. Therefore, although such foam shows the description which deforms elastically in the very small compression range, to compression which exceeds an elastic deformation limitation, said sheet which constitutes foam, or a film top Plastic solid fractures it, and it makes foam generate a crack, when foam is form by use as a raw material the resin in which drawing 4 or a stress-strain curve as show in 5 is show.

[0028] Moreover, the cellular structure of the foam in this invention is devised the maximum student or for the purpose of \*\*\*\*\* in the description of said polyolefin resin which constitutes foam, and describes the explanation below.

[0029] Although the polyolefin resin used for this invention is resin with the large rate of the plastic-like deformation, in the range until it continues till the yield point in a stress-strain curve, the rate of elastic deformation is large. Therefore, when compressing between compression mold and giving a concavo-convex configuration using the foam which consists of above-mentioned polyolefin resin, it is necessary to transform said sheet which constitutes foam, or a film-like air-bubbles wall even into the field to which the rate of the plastic-like deformation becomes large. According to the cellular structure of the foam used for this invention being longwise, as shown in drawing 6, a cellular wall shows [ of foam ] deformation of big bending from thickness to a carrier beam case for compression. As for the cellular wall which, on the other hand, constitutes the foam which has spherical air bubbles, compression does not change the configuration to a carrier beam case a lot. That is, the deformation of the cellular wall per deformation of foam becomes large to the cellular wall with which the sheet which constitutes the foam in this invention, or a film-like air-bubbles wall constitutes the foam which has spherical air bubbles.

[0030] Therefore, in compression between compression mold, even if it is the case that irregularity is small, a cellular wall can receive the deformation to which the rate of plasticity-deformation is sufficient for becoming large, and even if it is a complicated or very small configuration, the good foam of mold imprint nature is obtained.

[0031]

[Example] Hereafter, although an example and the example of a comparison explain this invention in more detail, this invention is not limited to these examples.

[0032] The synthetic example of the foam used in the examples 1-2 is shown below.

[0033] 2 and the mixture which consists of the 5-dimethyl-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.4 weight section were adjusted as a foaming agent to the synthetic example 1 high-density-polyethylene (TOSOH CORP. make, trade name NIPORON hardware 4010) 100 weight section as the AZOJI carvone amide (Eiwa Chemical Ind., Inc. make, trade name BINIHORU AC#1C) 5 weight section and a cross linking agent. While carrying out melting kneading of this mixture with 50mmphi extruder, it extruded as a non-foamed sheet through the T die.

[0034] Subsequently, after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 130 degrees C, foam was obtained by opening.

[0035] The air bubbles of the obtained foam were longwise, the open direction, i.e., thickness direction, of the above-mentioned metal mold, and the diameter ratio of air bubbles expressed with the diameter of air bubbles of the direction where expansion ratio is vertical to the diameter of air bubbles / the thickness direction of 10 times, the thickness of 30mm, and the thickness direction was foam which is the range of 3-7.

As opposed to the synthetic example 2 ethylene propylene random-copolymer (Chisso petrochemical incorporated company make, trade name Chisso polypropylene XF1800) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 7 weight section, as a cross linking agent — 2 and 5-dimethyl-G t-butyl peroxyhexane (the Nippon Oil & Fats Co., Ltd. make —) After adjusting the mixture which consists of the divinylbenzene (made in [ industrial incorporated company ] formation [ Tokyo ]) 0.8 weight section as the trade name par hexane 25B-40 0.08 weight section and a bridge formation assistant, foaming was performed after sheet forming like the synthetic example 1.

[0036] The air bubbles of the obtained foam were longwise in the thickness direction, and expansion ratio was foam the range of 15 times, the thickness of 45mm, and whose diameter ratio of air bubbles is 4-8.

[0037] Based on drawing 7 and 8, it explains about one or less example and the example which embodied this invention. This example is the case where this invention is applied, when fabricating the foam which has a concavo-convex configuration from the foam obtained in the above-mentioned synthetic example 1.

[0038] At the time of compression, the compression side adjacent to a foam side has a concavo-convex configuration, the flute length 7 was set to 10mm, and the compression mold 6 in drawing 7 set the flute width 8 to 5mm.

[0039] As the thickness of 1mm is sliced from a front face, the slice cut surface of foam touches a compression mold side and foam 10 is shown in drawing 8 (a) It was made to compress [ by being installed between the compression mold 6 which is not heated and the plate-like compression mold 9, and dropping compression mold successively ] 10mm by the flute length that is, to be shown in drawing 8 R>8 (b) by carrying out the compression side of a concavo-convex configuration in contact with a foam side, and subsequently pressurizing foam. And after holding for 1 minute with the condition of drawing 8 (b), as shown in drawing 8 (c), metal mold was opened, and foam was taken out.

[0040] Compression molding between compression mold was performed by the same approach as an example 1 using the foam obtained in the example 2 of example 2 composition.

[0041] By the same approach as an example 1, compression molding between compression mold was performed for the foam shown in one to example of comparison 4 table 1. In addition, the foam of 1-5 which are shown in a table 1 is explained below.

[0042] The example 1 of a comparison: It is foam to which cut the foam of an example 1 from a direction [ \*\*\* / direction / thickness ] in the location of arbitration, and it was made for a cutting plane to touch the compression side of compression mold.

[0043] Example [ of a Comparison ] 2: The The Dow Chemical Co. make, the example 3 of a trade name Styrofoam comparison : Toyo Tire & Rubber CO., LTD. The example 4 of a trade name SOFURAN-R board comparison : As opposed to Bridgestone Corp.

and the example of trade name ever light comparison 5 ethylene vinyl acetate copolymer (TOSOH CORP. make, trade name URUTORASEN 540) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.3 weight section as a cross linking agent, sheet forming was carried out like the synthetic example 1. And after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 100 degrees C, foam was obtained by opening. The obtained foam has longwise air bubbles in the thickness direction, and the foam the range of expansion ratio of 10 times, the thickness of 30mm, and whose diameter ratio of air bubbles is 3-6 was obtained. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0044] As opposed to the example of comparison 6 low-density-polyethylene (TOSOH CORP. make, trade name PETOROSEN 339) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.3 weight section as a cross linking agent, sheet forming was carried out like the synthetic example 1. And after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 110 degrees C, foam was obtained by opening. The obtained foam has longwise air bubbles in the thickness direction, and the foam the range of expansion ratio of 10 times, the thickness of 30mm, and whose diameter ratio of air bubbles is 2-5 was obtained. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0045] As opposed to the example of comparison 7 high-density-polyethylene (TOSOH CORP. make, trade name NIPORON hardware 4010) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#1C) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.6 weight section as a cross linking agent, sheet forming was performed like the synthetic example 1. and after insert into the cavity of the division metal mold which made the side face of a cavity incline so that a cavity may diffuse this non-foam sheet towards the die matching section currently maintain by 180 degrees C, and pressurize by the pressure of 20 kgf/cm<sup>2</sup>, gas be generated in melting resin by carry out temperature up of this die to 200 degrees C, and make a foaming agent disassemble. Then, after cooling the above-mentioned die at 130 degrees C, the foam which expanded in three dimension was obtained by opening.

[0046] The cellular structure of the obtained foam was spherical, and it was foam which is the expansion ratio of 10 times, and the thickness of 20mm. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0047] As opposed to the example of comparison 8 ethylene propylene random-copolymer (Chisso petrochemical incorporated company make, trade name Chisso polypropylene XF1800) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 12 weight section, as a cross linking agent — 2 and 5-dimethyl-G t-butyl peroxyhexane (the Nippon Oil & Fats Co., Ltd. make —) After adjusting the mixture which consists of the divinylbenzene (made in [ industrial incorporated company ] formation [ Tokyo ]) 0.8 weight section as the trade name par hexane 25B-40 0.08 weight section and a bridge formation assistant, sheet forming was carried out like the synthetic example 1, and, subsequently foaming was performed.

[0048] The air bubbles of the obtained foam were longwise in the thickness direction, and expansion ratio was foam the range of 25 times, the thickness of 75mm, and whose diameter ratio of air bubbles is 6-15. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0049] The description of the foam used for examples 1-2 and the examples 1-8 of a comparison and the description of the foam after compression molding between compression mold are summarized, and it is shown in a table 1. In addition, the explanation about each item in a table 1 is described below.

[0050] (Yield point) It is JIS about the sheet obtained after carrying out heating compression with the compacting machine which has the each plate-like compression mold with which a couple counters the foam used for compression molding and fabricating on a sheet with a thickness of 1mm. According to 7113 (1981), it pierced to the No. 2 form test piece, and the tension test was performed on a part for speed-of-testing/of 50mm, and conditions with a measurement temperature of 23 degrees C. And the existence of the yield point was investigated from the stress-strain curve obtained by the tension test.

[0051] (The amount of distortion) It asked for the stress in the yield point, i.e., yield strength, from the stress-strain curve used for decision of the above-mentioned yield point existence. And it follows towards the increment in distortion of a stress-strain curve, and the amount of distortion in the point which shows the same stress as yield strength except the yield point is calculated. In addition, the amount of distortion is a value acquired by \*\*(ing) distance between the marked lines in a test piece which changed in the original distance between the marked lines, and multiplying by 100.

[0052] (Diameter ratio of air bubbles) the diameter of air bubbles of a direction vertical to the diameter of air bubbles of the thickness direction, and the thickness direction about the air bubbles which cut the foam used for compression molding from a direction [ \*\*\*\* / direction / thickness ] in the location of arbitration, and are accepted in 2 an area of 4cm of this cutting plane — respectively — measuring — the diameter of air bubbles of the thickness direction — the diameter of air bubbles of a direction vertical to the thickness direction — \*\*\*\* — it asked for the diameter ratio of air bubbles by things.

[0053] (Divide) By compression between compression mold, the air bubbles of a foam surface say the phenomenon in which \*\*\*\*\* and a foam surface split. The judgment was judged in accordance with the following criterion by viewing.

O : — a crack — it splits [ both ] and nothing — although there is a \*\*:crack — splitting — nothing — take out x:crack and the foam which splits [ both ], exists (recoverability) and was compressed into the concavo-convex configuration, and leave it for 24 hours. And based on the result of having measured the die length of the slot of the formed concavo-convex section, it judged by the following decision criterion.

[0054] O : for the slot of 10% or more less than 90% of die length, the slot of less than 10% of die length is [ the slot of 90% or more of die length / foam ] generation [0055] to foam to the die length of the slot of generation x:compression mold to the die length of the slot of generation \*\*:compression mold to the die length of the slot on the compression mold in foam.

[A table 1]

	発泡体					割れ	回復性
	原料樹脂	降伏点	歪み屈 (%)	発泡倍率 (倍)	気泡径比 (-)		
実施例 1	高密度ポリエチレン	有	520	10	3~7	○	○
実施例 2	エチレン-プロピレンランダム共重合体	有	450	15	4~8	○	○
比較例 1	高密度ポリエチレン	有	520	10	0.1~0.3	○	△
比較例 2	ポリスチレン	無	-	30	1	×	△
比較例 3	硬質ポリウレタン	-	-	15	1	×	△
比較例 4	軟質ポリウレタン	無	-	15	1	○	△
比較例 5	エチレン-酢酸ビニル共重合体	-	-	10	3~6	○	×
比較例 6	低密度ポリエチレン	有	120	10	2~5	○	×
比較例 7	高密度ポリエチレン	有	500	10	1	○	△
比較例 8	エチレン-プロピレンランダム共重合体	有	480	25	6~15	△	○

## [0056]

[Effect of the Invention] According to this invention, the foam which has a concavo-convex configuration can be easily obtained by compression between compression mold. Because, since compression mold does not need a heating cooling system, a facility burden is relieved by facility facilitation and, also industrially, it can grow into limited production with a wide variety with the convenient shaping approach. Moreover, since a heating cooldown delay can be excluded and a complicated process is not needed, either, the foam of a concavo-convex configuration by which the molding cycle has been improved remarkably can be offered.

[0057] Since the compression-molding approach in this invention demonstrates the above effectiveness, it is applicable to shaping of the various products represented below.

[0058] (1) Coverings, such as housing building-materials (3) packing relevant to autoparts (2) floors, such as an instrument panel, a door trim, a pillar, and head-lining material, a wall, head lining, etc., a packing-material (4) household-electric-appliances device, a pocket device, and an information related equipment

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**TECHNICAL FIELD**

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[Field of the Invention] This invention relates to the compression-molding approach of the polyolefin resin foam which has the concavo-convex configuration used for various building materials, a heat insulator, covering, a packing material, etc.

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**PRIOR ART**

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[Description of the Prior Art] Validity and in order to use for a field probably, the attempt which functions the buffer nature which foam has conventionally, adiathermic, etc. has been made in various configurations to foam. For example, in using polyolefin resin as a raw material, after giving a configuration by using the thermoplasticity, compressing foam with the heated metal mold, and carrying out heating deformation, the method of making the cutting processing approaches, such as a method of carrying out cooling solidification and obtaining a product or decision, punching, and a slice, and the pad material of a predetermined configuration, or facing rival using adhesives etc. is adopted widely industrially.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] According to this invention, the foam which has a concavo-convex configuration can be easily obtained by compression between compression mold. Because, since compression mold does not need a heating cooling system, a facility burden is relieved by facility facilitation and, also industrially, it can grow into limited production with a wide variety with the convenient shaping approach. Moreover, since a heating cooldown delay can be excluded and a complicated process is not needed, either, the foam of a concavo-convex configuration by which the molding cycle has been improved remarkably can be offered.

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[0058] (1) Coverings, such as housing building-materials (2) floors, such as an instrument panel, a door trim, a pillar, and head-lining material, a wall, head lining, etc., a packing-material (4) household-electric-appliances device, a pocket device, and an information related equipment

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] However, in the approach of carrying out heating softening of the foam performed conventionally once by heat compression, and obtaining a product, heating cooling of foam takes time amount by the heat insulation function which foam has, there is a problem that a molding cycle is inferior to productivity for a long time, and if it is going to solve this by making the number of pages of metal mold increase, while a facility burden will become large, aggravation of workability is invited. Furthermore, in connection with carrying out heating softening of the foam, the air bubbles in foam weld and the inconvenience of spoiling lightweight nature, adiathermic, etc. arises.

[0004] Moreover, when un-heating tended to perform these compression and it was going to give a concavo-convex configuration to foam, it was difficult to give a concavo-convex configuration according to the buffer capacity of foam, in order to recover a concavo-convex configuration immediately or gradually. Moreover, if non-heating compression is performed using the rigid high foam constituted by the rigid plastic, although reduction-sized, since recovery of the above-mentioned irregularity becomes easy to produce a crack into details when the increment in brittleness tends to give a complicated configuration, or when irregularity is large, it will become a scarce product at concavo-convex imprint nature.

[0005] Moreover, if it is in the approach of carrying out cutting processing of the foam by decision, punching, a slice, etc. at a predetermined configuration, since the increment in a help or working hours is brought about and it leads to the cost rise of a product with complication of a configuration, a processible product will be restricted to a simple configuration.

[0006] Furthermore, if it is in the approach of making the pad material of a predetermined configuration, or facing rivaling using adhesives, since conditions, such as the adhesive property of foam, adhesives, or lamination material and adhesives and the front-face nature of foam, are strongly related in bond strength, the foam used will be limited to the foam corresponding to these conditions. Moreover, since two or more processes, such as an adhesives spreading process, a lamination process, an adhesives desiccation process, a press process, and a cooling process, are needed, there is a problem that a facility burden is large and a molding cycle becomes long.

[0007] The object of this invention is to offer the approach of fabricating the polyolefin resin foam which has a concavo-convex configuration efficiently with compression molding by un-heating [ which solved the above-mentioned conventional problem ].

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## MEANS

[Means for Solving the Problem] As a result of examining the above-mentioned problem wholeheartedly, by applying compression to specific polyolefin resin foam by un-heating, this invention person finds out that the foam of a concavo-convex configuration which has the outstanding imprint nature is obtained, and came to complete this invention.

[0009] Namely, this invention compresses polyolefin resin foam between the compression mold which counters, and sets it to the compression-molding approach of giving a concavo-convex configuration to the polyolefin resin foam side which touches this compression mold. Speed-of-testing the stress-strain curve for / of 50mm in a tension test has (1) yield point. (2) It consists of polyolefin resin which satisfies that distortion by the point which shows the same stress as yield strength is 400% or more except the yield point. Cellular structure is still more nearly longwise in the thickness direction. The diameter ratio of air bubbles expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction is related with the compression-molding approach of the polyolefin resin foam characterized by performing compression molding of the polyolefin resin foam which is 2-10 by un-heating.

[0010] Hereafter, this invention is explained in full detail.

[0011] Distortion by the point which a part for speed-of-testing / of 50mm in a tension test (JIS K 7113 1981) and a stress-strain curve with a measurement temperature of 23 degrees C have (1) yield point as polyolefin resin used as foam in this invention, and shows the same stress as yield strength except (2) yield points is polyolefin resin which is 400% or more. When non-heating compression of the foam which consists of polyolefin resin in which the yield point is not accepted here is carried out with the compression mold which has a concavo-convex configuration, the foam which the crack arose in the concavo-convex section of foam, or the concavo-convex configuration was recovered immediately or gradually after compression, and was excellent in concavo-convex imprint nature is not desirable from not being obtained. Moreover, when distortion by the point which shows the same stress as yield strength except the yield point carries out non-heating compression of the foam which consists of polyolefin resin which is not filled to 400% as well as the above, the foam obtained is not desirable from becoming what transforms elastically and the given concavo-convex configuration does not maintain.

[0012] As polyolefin resin used in this invention A part for speed-of-testing / of 50mm in a tension test (JIS K7113 1981), A stress-strain curve with a measurement temperature of 23 degrees C has (1) yield point, and anythings can be used if distortion by the point which shows the same stress as yield strength except (2) yield points is polyolefin resin which is 400% or more. A part for for example, speed-of-testing / of 50mm in a tension test (JIS K 7113 1981), The ethylene-propylene block copolymer whose distortion by the point which a stress-strain curve with a measurement temperature of 23 degrees C has (1) yield point, and shows the same stress as yield strength except (2) yield points is 400% or more. The consistency obtained by carrying out a polymerization by inside and the low voltage polymerization method The high density polyethylene of 0.94 - 0.97 g/cm<sup>3</sup>, A polypropylene homopolymer, an ethylene-propylene random copolymer, or a propylene-alpha olefin copolymer is mentioned. Here as an alpha olefin For example, 1-butene, 1-pentene, 1-hexene, 4-methyl-1-pentene, 1-octene, etc. can be mentioned.

Moreover, independent or two sorts or more may be used together and used for these polyolefin resin.

[0013] Moreover, the polyolefin resin used in this invention may mix a filler etc., and talc, a calcium carbonate, a silica, a mica, carbon black, a metal powder, a glass fiber, carbon fiber, a magnesium hydroxide, an antimony trioxide, way acid zinc, a bromine compound, a ceramic, a zeolite, etc. are mentioned as this filler, for example. moreover, these fillers are independent — or it can use together and use.

[0014] The polyolefin resin foam used for this invention is characterized by the diameter ratios of air bubbles to which cellular structure is longwise expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction in the thickness direction being 2-10. When the diameter ratio of air bubbles is less than two, deformation of the foam by non-heating compression will become elastic, and a concavo-convex configuration continues and is not desirable. Since the reinforcement of foam falls remarkably and it sets on the other hand at the time of compression, since the cellular wall which separates the air bubbles in foam will be in the condition of having been extended very long and slender when the diameter ratio of air bubbles exceeds 10, and foam itself is deformed or crushed, it is not desirable.

[0015] It is not limited especially if the polyolefin resin foam whose diameter ratios of air bubbles to which cellular structure is longwise expressed with the diameter of air bubbles of a direction vertical to the diameter of air bubbles / the thickness direction of the thickness direction in the thickness direction as the manufacture approach of the above-mentioned polyolefin resin foam are 2-10 is obtained, and one example of the manufacture approach is shown below.

[0016] Chemistry cross linking agents, such as a peroxide, are mixed with - dinitrosopentamethylenetetramine, and chemistry foaming agent which decomposes into polyolefin resin with heating and may generate gas, for example, AZOJI carvone amide, N, and N'4, 4'-oxy-SUBISU (benzenesulphonyl hydrazide), a sodium hydrogencarbonate, etc. if needed, while this mixture had been made to hold to the temperature which a chemistry foaming agent and a cross linking agent do not decompose, melting kneading is carried out, for example, it fabricates to Plastic solids, such as the shape of a sheet. And it is heated more than the decomposition temperature of the above-mentioned foaming agent, and by subsequently opening the above-mentioned die, application-of-pressure resin expands two-dimensional, and the sheet which has the acquired fizz is changed into the foam 3 for which it asks while being pressurized within the die 1 of the couple which counters, and 2, as shown in drawing 1.

[0017] As a chemistry cross linking agent added by the manufacture approach of the above-mentioned foam, there are silane compounds, such as azide compounds, such as organic peroxide [, such as benzoyl peroxide, 2,5-dimethyl-2,5-di-t-butyl peroxyhexane, 2, the 5-dimethyl-2-5-G t-butyl par OKISHIHEKISHIN -3, dicumyl peroxide, and t-butyl hydroxy peroxide, ] or 1, and 9-nonane bis-sulfone AZAIDO, or vinyltriethoxysilane, etc., for example. Moreover, for example, a triaryl SHIANU rate, triallyl isocyanurate, trimethylolpropanetrimethacrylate, 1, 2-polybutadiene, a divinylbenzene, etc. can be used together as a bridge formation assistant which promotes bridge formation in this case.

[0018] Moreover, as for the amount of mixing of the above-mentioned cross linking agent, it is desirable that it is 0 - 0.5 % of the weight, when mixed exceeding 0.5 % of the weight, since the high-concentration structure of cross linkage is introduced into resin and the viscosity of the resin at the time of foaming rises remarkably, growth of air bubbles is checked and the air bubbles extended by the one direction long and slender cannot be obtained.

[0019] It consists of a mold of the couple which counters, for example as compression mold which gives a concavo-convex configuration to polyolefin resin foam by un-heating in this invention, and it consists of a roll of that into which a mold face can compress foam in contact with a foam front face by eye a mold clamp, and the couple which a peripheral face counters, and

there are some which can compress foam in the clearance between the rolls which rotate to the inside sense mutually. [0020] Moreover, the concavo-convex section is prepared in the above-mentioned compression mold side, and when these irregularity section is imprinted by the polyolefin resin foam side, the polyolefin resin foam which has a concavo-convex configuration is obtained. in addition, the thing to which especially the class of concavo-convex configuration of the above-mentioned compression mold side is limited — it is not — concavo-convex configurations, such as an embossing pattern, a variegated pattern, the crest end, a cone, the square pole, a rectangular-head drill, a triangular pyramid, and a semi-sphere, — independence — or it can be made to be able to compound-ize and can use.

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## OPERATION

(Operation) Foam is compressed by un-heating, in order to obtain the product excellent in mold imprint nature, when compressed between compression mold, foam must be made to transform in plasticity, and, moreover, complicated concavo-convex details must not be made to generate a crack. this invention person found out playing a role with the polyolefin resin which constitutes foam and the cellular structure of foam important for solution of these technical problems. The explanation is described below.

[0022] The resin of the perimeter of air bubbles in foam is extended a sheet or in the shape of a film with growth of air bubbles at the time of foaming. That is, since the cellular wall which separates the air bubbles in foam is resin of the shape of a sheet or a film, foam can be considered to be also the aggregate of the extended sheet or a film-like Plastic solid. Therefore, it is deeply concerned with making it transform in plasticity to make foam transform in plasticity by compression, i.e., the above-mentioned film-like Plastic solid.

[0023] The tension test approach is widely used as a general approach from before as an approach of evaluating the mechanical property of the above-mentioned sheet or a film-like Plastic solid. by the tension test, a sheet or the resin test piece fabricated in the shape of a film is pulled mechanically, and the stress value over each distortion is expressed with a curve. The stress-strain curve of the polyolefin resin used for this invention is shown in drawing 2. In addition, 4 is the yield point, and it defines as drawing 2 as first point that the increment in distortion is accepted without change of stress on the stress-strain curve by the tension test, and, generally the stress in this point is called yield strength. In the stress-strain curve of drawing 2, the force in which it returns to the test piece which deformed from stress increasing with change of distortion till the yield point 4 will be added from the point of distortion 0, and it can be called the field where the rate which deforms elastically is large. However, after the yield point, the field where the increment in the stress by deformation is not accepted exists, and deformation has the plastic-like element with it in such a field. Moreover, after the point 5 which the deformation field which has said plastic-like element ended, again, since the increment in stress is accepted to deformation, the rate which a test piece deforms elastically between the point of curve top 5 and the point after curve top 5 will become large.

[0024] Therefore, in order to make the sheet or film-like Plastic solid in said foam deform in plasticity at the time of compression, the field where the rate of the plastic-like deformation is large should just fabricate foam in a stress-strain curve using resin which exists over the high range more.

[0025] That is, since distortion by the point which the polyolefin resin in this invention has the yield point in the stress-strain curve in a tension test, and shows the same stress as yield strength except the yield point is 400% or more, the foam constituted by this polyolefin resin becomes what has the large rate of plasticity-deformation at the time of compression by compression mold.

[0026] The stress-strain curve in the tension test of the resin which, on the other hand, constitutes flexible foam which is conventionally used for a buffer application is classified into a type as shown in drawing 3. Since there is no yield point in the stress-strain curve shown in drawing 3 and stress continues increasing with the increment in distortion, the rate of elastic deformation is large. Therefore, although the foam which makes a component the resin expressed by such stress-strain curve shows adaptability and elastic recoverability to deformation, it is inferior to the imprint nature of the concavo-convex configuration by the non-heating compression which used compression mold.

[0027] Moreover, many of hard foam with the conventionally large rate of the plastic-like deformation makes the component the resin expressed with the stress-strain curve of the type shown in drawing 4 or drawing 5. The stress-strain curve which the stress-strain curve shown in drawing 4 means that a test piece fractures before reaching according to deformation at the yield point, and is shown in drawing 5 means that a test piece fractures near the yield point. Therefore, although such foam shows the description which deforms elastically in the very small compression range, to compression which exceeds an elastic deformation limitation, said sheet which constitutes foam, or a film top Plastic solid fractures it, and it makes foam generate a crack, when foam is form by use as a raw material the resin in which drawing 4 or a stress-strain curve as show in 5 is show.

[0028] Moreover, the cellular structure of the foam in this invention is devised the maximum student or for the purpose of \*\*\*\*\* in the description of said polyolefin resin which constitutes foam, and describes the explanation below.

[0029] Although the polyolefin resin used for this invention is resin with the large rate of the plastic-like deformation, in the range until it continues till the yield point in a stress-strain curve, the rate of elastic deformation is large. Therefore, when compressing between compression mold and giving a concavo-convex configuration using the foam which consists of above-mentioned polyolefin resin, it is necessary to transform said sheet which constitutes foam, or a film-like air-bubbles wall even into the field to which the rate of the plastic-like deformation becomes large. According to the cellular structure of the foam used for this invention being longwise, as shown in drawing 6, a cellular wall shows [ of foam ] deformation of big bending from thickness to a carrier beam case for compression. As for the cellular wall which, on the other hand, constitutes the foam which has spherical air bubbles, compression does not change the configuration to a carrier beam case a lot. That is, the deformation of the cellular wall per deformation of foam becomes large to the cellular wall with which the sheet which constitutes the foam in this invention, or a film-like air-bubbles wall constitutes the foam which has spherical air bubbles.

[0030] Therefore, in compression between compression mold, even if it is the case that irregularity is small, a cellular wall can receive the deformation to which the rate of plasticity-deformation is sufficient for becoming large, and even if it is a complicated or very small configuration, the good foam of mold imprint nature is obtained.

## EXAMPLE

[Example] Hereafter, although an example and the example of a comparison explain this invention in more detail, this invention is not limited to these examples.

[0032] The synthetic example of the foam used in the examples 1-2 is shown below.

[0033] 2 and the mixture which consists of the 5-dimethyl-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.4 weight section were adjusted as a foaming agent to the synthetic example 1 high-density-polyethylene (TOSOH CORP. make, trade name NIPORON hardware 4010) 100 weight section as the AZOJI carvone amide (Eiwa Chemical Ind., Inc. make, trade name BINIHORU AC#1C) 5 weight section and a cross linking agent. While carrying out melting kneading of this mixture with 50mmphi extruder, it extruded as a non-foamed sheet through the T die.

[0034] Subsequently, after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 130 degrees C, foam was obtained by opening.

[0035] The air bubbles of the obtained foam were longwise, the open direction, i.e., thickness direction, of the above-mentioned metal mold, and the diameter ratio of air bubbles expressed with the diameter of air bubbles of the direction where expansion ratio is vertical to the diameter of air bubbles / the thickness direction of 10 times, the thickness of 30mm, and the thickness direction was foam which is the range of 3-7.

As opposed to the synthetic example 2 ethylene propylene random-copolymer (Chisso petrochemical incorporated company make, trade name Chisso polypropylene XF1800) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 7 weight section, as a cross linking agent — 2 and 5-dimethyl-G t-butyl peroxyhexane (the Nippon Oil & Fats Co., Ltd. make —) After adjusting the mixture which consists of the divinylbenzene (made in [ industrial incorporated company ] formation [ Tokyo ]) 0.8 weight section as the trade name par hexane 25B-40 0.08 weight section and a bridge formation assistant, foaming was performed after sheet forming like the synthetic example 1.

[0036] The air bubbles of the obtained foam were longwise in the thickness direction, and expansion ratio was foam the range of 15 times, the thickness of 45mm, and whose diameter ratio of air bubbles is 4-8.

[0037] Based on drawing 7 and 8, it explains about one or less example and the example which embodied this invention. This example is the case where this invention is applied, when fabricating the foam which has a concavo-convex configuration from the foam obtained in the above-mentioned synthetic example 1.

[0038] At the time of compression, the compression side adjacent to a foam side has a concavo-convex configuration, the flute length 7 was set to 10mm, and the compression mold 6 in drawing 7 set the flute width 8 to 5mm.

[0039] As the thickness of 1mm is sliced from a front face, the slice cut surface of foam touches a compression mold side and foam 10 is shown in drawing 8 (a) It was made to compress [ by being installed between the compression mold 6 which is not heated and the plate-like compression mold 9, and dropping compression mold successively ] 10mm by the flute length that is, to be shown in drawing 8 R> 8 (b) by carrying out the compression side of a concavo-convex configuration in contact with a foam side, and subsequently pressurizing foam. And after holding for 1 minute with the condition of drawing 8 (b), as shown in drawing 8 (c), metal mold was opened, and foam was taken out.

[0040] Compression molding between compression mold was performed by the same approach as an example 1 using the foam obtained in the example 2 of example 2 composition.

[0041] By the same approach as an example 1, compression molding between compression mold was performed for the foam shown in one to example of comparison 4 table 1. In addition, the foam of 1-5 which are shown in a table 1 is explained below.

[0042] The example 1 of a comparison: It is foam to which cut the foam of an example 1 from a direction [ \*\*\*\* / direction / thickness ] in the location of arbitration, and it was made for a cutting plane to touch the compression side of compression mold.

[0043] Example [ of a Comparison ] 2: The The Dow Chemical Co. make, the example 3 of a trade name Styrofoam comparison : Toyo Tire & Rubber CO., LTD. The example 4 of a trade name SOFURAN-R board comparison : As opposed to Bridgestone Corp. and the example of trade name ever light comparison 5 ethylene vinyl acetate copolymer (TOSOH CORP. make, trade name URUTORASEN 540) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.3 weight section as a cross linking agent, sheet forming was carried out like the synthetic example 1. And after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 100 degrees C, foam was obtained by opening. The obtained foam has longwise air bubbles in the thickness direction, and the foam the range of expansion ratio of 10 times, the thickness of 30mm, and whose diameter ratio of air bubbles is 3-6 was obtained. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0044] As opposed to the example of comparison 6 low-density-polyethylene (TOSOH CORP. make, trade name PETOROSEN 339) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.3 weight section as a cross linking agent, sheet forming was carried out like the synthetic example 1. And after inserting this non-foamed sheet between the dice with which the couple with concave and a convex configuration currently maintained by 180 degrees C counters, respectively and pressurizing it by the pressure of 20 kgf/cm<sup>2</sup>, gas was generated in melting resin by carrying out temperature up of this die to 200 degrees C, and making a foaming agent disassemble. Then, after cooling the above-mentioned die at 110 degrees C, foam was obtained by opening. The obtained foam has longwise air bubbles in the thickness direction, and the foam the range of expansion ratio of 10 times, the thickness of 30mm, and whose diameter ratio of air bubbles is 2-5 was obtained. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0045] As opposed to the example of comparison 7 high-density-polyethylene (TOSOH CORP. make, trade name NIPORON hardware 4010) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#1C) 5 weight section, After adjusting 2, the 5-dimethyl -2, and the mixture that consists of the 5-G t-butyl par

OKISHIHEKISHIN-3 (Nippon Oil & Fats Co., Ltd. make, trade name par hexyne 25B-40) 0.6 weight section as a cross linking agent, sheet forming was performed like the synthetic example 1, and after insert into the cavity of the division metal mold which made the side face of a cavity incline so that a cavity may diffuse this non-foam sheet towards the die matching section currently maintain by 180 degrees C, and pressurize by the pressure of 20 kgf/cm<sup>2</sup>, gas be generated in melting resin by carry out temperature up of this die to 200 degrees C, and make a foaming agent disassemble. Then, after cooling the above-mentioned die at 130 degrees C, the foam which expanded in three dimension was obtained by opening.

[0046] The cellular structure of the obtained foam was spherical, and it was foam which is the expansion ratio of 10 times, and the thickness of 20mm. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0047] As opposed to the example of comparison 8 ethylene propylene random-copolymer (Chisso petrochemical incorporated company make, trade name Chisso polypropylene XF1800) 100 weight section As a foaming agent, the AZOJI carvone amide (Eiwa Chemical Ind., Inc., trade name BINIHORU AC#3) 12 weight section, as a cross linking agent — 2 and 5-dimethyl-G t-butyl peroxyhexane (the Nippon Oil & Fats Co., Ltd. make —) After adjusting the mixture which consists of the divinylbenzene (made in [ industrial incorporated company ] formation [ Tokyo ]) 0.8 weight section as the trade name par hexane 25B-40 0.08 weight section and a bridge formation assistant, sheet forming was carried out like the synthetic example 1, and, subsequently foaming was performed.

[0048] The air bubbles of the obtained foam were longwise in the thickness direction, and expansion ratio was foam the range of 25 times, the thickness of 75mm, and whose diameter ratio of air bubbles is 6~15. And compression molding between compression mold was performed by the same approach as an example 1 using the obtained foam.

[0049] The description of the foam used for examples 1~2 and the examples 1~8 of a comparison and the description of the foam after compression molding between compression mold are summarized, and it is shown in a table 1. In addition, the explanation about each item in a table 1 is described below.

[0050] (Yield point) It is JIS about the sheet obtained after carrying out heating compression with the compacting machine which has the each plate-like compression mold with which a couple counters the foam used for compression molding and fabricating on a sheet with a thickness of 1mm. According to 7113 (1981), it pierced to the No. 2 form test piece, and the tension test was performed on a part for speed-of-testing/of 50mm, and conditions with a measurement temperature of 23 degrees C. And the existence of the yield point was investigated from the stress-strain curve obtained by the tension test.

[0051] (The amount of distortion) It asked for the stress in the yield point, i.e., yield strength, from the stress-strain curve used for decision of the above-mentioned yield point existence. And it follows towards the increment in distortion of a stress-strain curve, and the amount of distortion in the point which shows the same stress as yield strength except the yield point is calculated. In addition, the amount of distortion is a value acquired by \*\*(ing) distance between the marked lines in a test piece which changed in the original distance between the marked lines, and multiplying by 100.

[0052] (Diameter ratio of air bubbles) the diameter of air bubbles of a direction vertical to the diameter of air bubbles of the thickness direction, and the thickness direction about the air bubbles which cut the foam used for compression molding from a direction [ \*\*\*\* / direction / thickness ] in the location of arbitration, and are accepted in 2 an area of 4cm of this cutting plane — respectively — measuring — the diameter of air bubbles of the thickness direction — the diameter of air bubbles of a direction vertical to the thickness direction — \*\*\* — it asked for the diameter ratio of air bubbles by things.

[0053] (Divide) By compression between compression mold, the air bubbles of a foam surface say the phenomenon in which \*\*\*\*\* and a foam surface split. The judgment was judged in accordance with the following criterion by viewing.

O : — a crack — it splits [ both ] and nothing — although there is a \*\*:crack — splitting — nothing — take out x:crack and the foam which splits [ both ], exists (recoverability) and was compressed into the concavo-convex configuration, and leave it for 24 hours. And based on the result of having measured the die length of the slot of the formed concavo-convex section, it judged by the following decision criterion.

[0054] O : for the slot of 10% or more less than 90% of die length, the slot of less than 10% of die length is [ the slot of 90% or more of die length / foam ] generation [0055] to foam to the die length of the slot of generation x:compression mold to the die length of the slot of generation \*\*:compression mold to the die length of the slot on the compression mold in foam.

[A table 1]

	発泡体					割れ	回復性
	原料樹脂	降伏点	歪み量 (%)	発泡倍率 (倍)	気泡径比 (-)		
実施例 1	高密度ポリエチレン	有	520	10	3~7	○	○
実施例 2	エチレン-プロピレンランダム共重合体	有	450	15	4~8	○	○
比較例 1	高密度ポリエチレン	有	520	10	0.1~0.3	○	△
比較例 2	ポリスチレン	無	—	30	1	×	△
比較例 3	硬質ポリウレタン	—	—	15	1	×	△
比較例 4	軟質ポリウレタン	無	—	15	1	○	△
比較例 5	エチレン-酢酸ビニル共重合体	—	—	1.0	3~6	○	×
比較例 6	低密度ポリエチレン	有	120	10	2~5	○	×
比較例 7	高密度ポリエチレン	有	500	10	1	○	△
比較例 8	エチレン-プロピレンランダム共重合体	有	480	25	6~15	△	○

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**DESCRIPTION OF DRAWINGS**

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**[Brief Description of the Drawings]**

**[Drawing 1]** It is the explanatory view having shown the shaping approach of polyolefin resin foam typically.

**[Drawing 2]** It is the schematic diagram showing the stress-strain curve at the time of the tension test of polyolefin resin.

**[Drawing 3]** It is the schematic diagram showing the stress-strain curve at the time of the tension test of the resin which constitutes flexible foam.

**[Drawing 4]** It is the schematic diagram showing the stress-strain curve at the time of the tension test of the resin which constitutes hard foam.

**[Drawing 5]** It is the schematic diagram showing the stress-strain curve at the time of the tension test of the resin which constitutes hard foam.

**[Drawing 6]** It is the schematic diagram showing the cellular configuration at the time of compressing polyolefin resin foam.

**[Drawing 7]** It is the explanatory view having shown typically the configuration in the mold face of the compression-molding mold of an example 1.

**[Drawing 8]** It is drawing which explained typically the compression-molding approach of the polyolefin resin foam in an example 1.

**[Description of Notations]**

1: Top metal mold

2: Shimokane mold

3: Foam

4: Yield point

5: The point which the field where the rate of the plastic-like deformation in a stress-strain curve is large ended

6: Compression mold which has a concavo-convex side

7: The die-length part of the slot on the compression mold

8: The width-of-face part of the slot on the compression mold

9: Plate-like compression mold

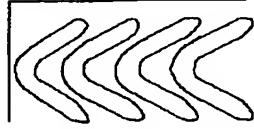
10: Foam used for compression molding

11: Foam which has a concavo-convex configuration

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## DRAWINGS

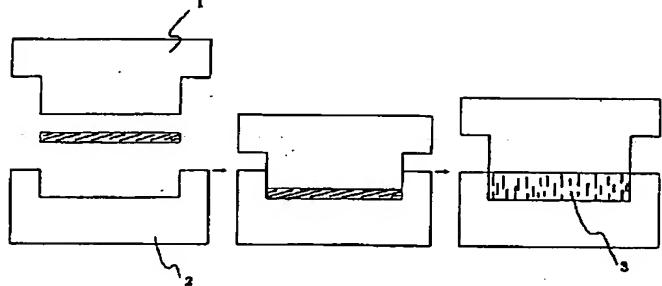
[Drawing 6]



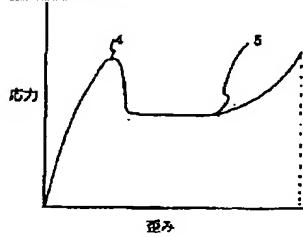
[Drawing 7]



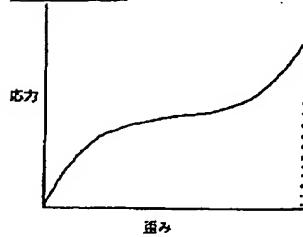
[Drawing 1]



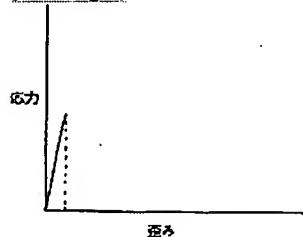
[Drawing 2]



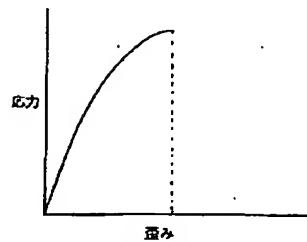
[Drawing 3]



[Drawing 4]

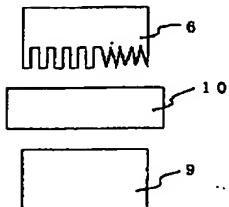


[Drawing 5]

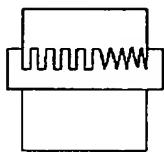


[Drawing 8]

(a)



(b)



(c)

